PATENT

MULTI-FIBER FERRULE FOR COATED OPTICAL FIBERS

FIELD OF THE INVENTION

[001] The present invention relates to a multi-fiber ferrule for coated optical fibers, and more particularly, to a multi-fiber ferrule that allows optical fibers from a fiber optic ribbon or buffered optical fibers to be easily inserted into and secured in the ferrule.

BACKGROUND OF THE INVENTION

[002] There are a number of prior art multi-fiber ferrules, however, none of these multi-fiber ferrules will easily accommodate optical fibers from both a fiber optic ribbon and buffered fibers. Typically, the multi-fiber ferrules have a configuration that allows for easy insertion of the fibers in the form of optical ribbons. However, the optical fibers that are buffered must be twisted and turned to be inserted into the ferrule. The twisting and turning of the buffered optical fibers can cause the optical fibers to be misaligned and can prevent the optical fibers from being properly secured with epoxy in the ferrule.

[003] Accordingly, the present invention is directed to a multi-fiber ferrule that substantially obviates one or more of the problems and disadvantages in the prior art. Additional features and advantages of the invention will be set forth in the description that follows, and in part will be apparent from the description, or may be learned by practice of the invention. The objectives and other advantages of the invention will be realized and attained by the apparatus and process particularly pointed out in the written description and claims, as well as the appended drawings.

SUMMARY OF THE INVENTION

[004] To achieve these and other advantages and in accordance with the purpose of the invention as embodied and broadly described herein, the invention is directed to a multi-fiber ferrule having a front face and an opposed rear face and defining a longitudinal axis in a lengthwise direction, the multi-fiber ferrule includes an optical fiber receiving portion adjacent the front face for receiving an end portion of at least one optical fiber, said optical fiber receiving portion comprising a plurality of optical fiber bores extending parallel to the longitudinal axis, a lead-in portion adjacent the rear face for receiving and guiding the at least one optical fiber into the multi-fiber ferrule, and an alignment portion between the optical fiber receiving portion and the lead-in portion for receiving the at least one optical fiber and aligning the end portion of the at least one optical fiber with a respective one of the plurality of optical fiber bores.

[005] In yet another aspect, the invention is directed to a multi-fiber ferrule body that includes a front face, an opposed rear face, an optical fiber receiving portion extending for a least a portion of a distance between the front and rear faces, the optical fiber receiving portion being adjacent the front face of the multi-fiber ferrule body to receive an end of at least one optical fiber and comprising a plurality of optical fiber bores extending from the front face toward the rear face, an alignment portion disposed between the optical fiber receiving portion and the rear face for receiving the at least one optical fiber and aligning the end portion of the at least one optical fiber with a respective one of the plurality of optical fiber bores, wherein the at least one optical fiber being chosen from the group consisting of a buffered optical fiber and an optical fiber ribbon.

[006] In another aspect, the present invention is directed to a multi-fiber ferrule having a front face and an opposed rear face and defining a longitudinal axis in a lengthwise direction, the multi-fiber ferrule includes an optical fiber receiving portion adjacent the front face for receiving an end portion of at least

one optical fiber, said optical fiber receiving portion comprising a plurality of optical fiber bores extending parallel to the longitudinal axis, a lead-in portion adjacent the rear face for receiving and guiding the at least one optical fiber into the multi-fiber ferrule, and an alignment portion between the optical fiber receiving portion and the lead-in portion for receiving the at least one optical fiber and aligning the end portion of the at least one optical fiber with a respective one of the plurality of optical fiber bores, the alignment portion defining at least a portion having a generally oval cross section and comprising at least one separating rib for separating a plurality of optical fibers.

[007] It is to be understood that the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[008] The accompanying drawings are included to provide a further understanding of the invention and are incorporated in and constitute a part of the specification. The drawings illustrate several embodiments of the invention and together with the description serve to explain the principles of the invention.

[009] FIG. 1 is a rear isometric view of a multi-fiber ferrule according to one embodiment of the present invention;

[010] FIG. 2 is a front isometric view of the multi-fiber ferrule of FIG. 1;

[011] FIG. 3 is a rear view of the multi-fiber ferrule of FIG. 1;

[012] FIG. 4 is a cross section view of the multi-fiber ferrule in FIG. 3 taken along the line 4-4;

[013] FIG. 5 is a cross section view of the multi-fiber ferrule in FIG. 4, with optical fibers positioned to be inserted;

[014] FIG. 6 is a partial cross sectional view of a portion of the optical fiber receiving portion and the alignment portion of the multi-fiber ferrule of FIG. 1;

[015] FIG. 7 is a cross section view of the multi-fiber ferrule in FIG. 1 taken along the line 7-7;

[016] FIG. 8 is an isometric view of a fiber optic connecter with the multi-fiber ferrule of FIG. 1 shown with two buffered optical fibers;

[017] FIG. 9 isometric view of a fiber optic connecter with the multi-fiber ferrule of FIG. 1 shown with an optical fiber ribbon;

[018] FIG. 10 is a rear view of a prior art ferrule; and

[019] FIG. 11 is a front isometric view of the ferrule of FIG. 10.

DETAILED DESCRIPTION OF THE INVENTION

[020] FIGS. 1-7 illustrate a multi-fiber ferrule **10** according to one embodiment of the present invention. The multi-fiber ferrule **10** is preferably a window-less type ferrule that has a front face **12** and a rear face **14**. However, the ferrule **10** may also have a window if so desired. As explained in more detail below, the configuration of the multi-fiber ferrule **10** obviates the specific advantages of a window. The multi-fiber ferrule **10** may also have a shoulder **16** to engage a fiber optic plug housing **18** (see FIGS. 8 & 9). Additionally, as is known in the art, the multi-fiber ferrule **10** shown and described herein has two fiber optic guide pin bores **20**, **22** to assist in aligning the multi-fiber ferrule **10** with another ferrule in a mated pair.

[021] Preferably, the multi-fiber ferrule **10** has an optical fiber receiving portion **23** (FIG. 7) that includes two optical fiber bores **24**, **26** to receive an end portion **28**, **32** of an optical fiber **30**, **34** (FIGS. 4 and 5). The optical fiber bores **24**, **26** are adjacent to and extend through the front face **12** of the multi-

fiber ferrule **10**. The end portion **28, 32** of the optical fiber **30, 34** is preferably stripped of any matrix material, buffer material or coating prior to be inserted into the multi-fiber ferrule **10**. As illustrated in FIG. 5, the optical fiber **30, 34** may be either an optical fiber ribbon **30** or a dual, buffered optical fiber cable **34** (for example, Mini-zip™ fiber optic cable available from Corning Cable Systems in Hickory, NC). As shown in FIG. 5, the center two optical fibers of the optical fiber ribbon **30** may either be severed or may be made with dummy fibers. Each of the buffered optical fibers in optical fiber cable **34** are typically 650 microns in diameter, but any size buffered optical fiber could be used. The end portions **28, 32** are striped of any matrix material, buffer material or coating so that the stripped optical fibers **36** are approximately 125 microns in diameter. The length of the stripped optical fibers **36** depends on the type of optical fiber, the dimensions of the multi-fiber ferrule **10**, and the post-insertion processing techniques.

[022] In order to be inserted into and through the optical fiber bores **24, 26**, the optical fibers **30, 34** are inserted into a tapered lead-in portion **38** adjacent the rear face **14** of the multi-fiber ferrule **10**. The lead-in portion **38** assists in guiding the optical fibers **30, 34** into the alignment portion **40** of the multi-fiber ferrule **10**. The lead-in portion **38** expands radially outward from a longitudinal axis **42** through the multi-fiber ferrule **10** in a direction from the alignment portion **40** to the rear face **14**. Thus, the shape of the lead-in portion **38** assists by guiding the optical fibers into the multi-fiber ferrule **10**, and more particularly, the alignment portion **40**. The lead-in portion **38** may expand in a linear fashion, providing for a straight wall **44** or it may also expand in a non-linear fashion causing the wall **44** to be curved.

[023] The alignment portion **40** of multi-fiber ferrule **10** preferably includes two portions – a buffered fiber alignment portion **46** and a ribbon alignment portion **48**. As best viewed in FIGS. 1, 3, and 4, the buffered alignment portion **46** is adjacent the lead-in portion **38** and generally has an oval cross section.

In one embodiment, the buffered alignment portion **46** has two generally circular portions **50, 52** that have a rib **54** therebetween to further distinguish the generally circular portions **50, 52**. The buffered alignment portion **46** may also be two overlapping truncated circular portions. The rib **54** need not be present, but assists in separating and aligning the buffered optical fibers **34** in the multi-fiber ferrule **10**, and more particularly, aligning them parallel to the longitudinal axis **42**. As the buffered optical fibers **34** are inserted into the multi-fiber ferrule **10**, the lead-in portion **38** guides them into the buffered alignment portion **46,** where the two generally circular (in cross section) portions **50, 52** and rib **54** separate and orient the buffered optical fibers **34** and the stripped optical fibers **36** with respective ones of the optical fiber bores **22, 24**. The rib **54** assists in preventing the buffered optical fibers **34** from twisting and crossing over one another, as can occur in the prior art ferrules. As seen in FIG. 10, the opening in the back of the prior art ferrule is rectangular and does not provide any guidance or alignment to a buffered optical fiber. The rib **54** could be omitted entirely, made smaller, or even larger, provided there is sufficient space to allow the buffered optical fibers **34** to pass through the generally circular portions **50, 52**. Furthermore, the rib **54** may have any convenient shape ad may be molded into the multi-fiber ferrule **10**, machined into the multi-fiber ferrule **10**, or formed in any suitable manner.

[024] While the portions **50, 52**, are illustrated to be generally circular, they could of any configuration that would assist in orienting the optical fibers **30, 34**, including, for example, oval, hexagonal, etc. The buffered optical fibers **34** are then inserted until the buffer portion of the buffered optical fibers **34** makes contact with a shoulder **56**. See FIG. 7. As noted above, the alignment portion **40** in the preferred embodiment is sized for a 650 micron buffered optical fiber. However, the buffered alignment portion **46** could be sized for any size buffered optical fibers, or even for any number of optical fibers.

[025] The alignment portion **40** of multi-fiber ferrule **10** also includes a ribbon alignment portion **48**. The ribbon alignment portion **48** is adjacent the buffered alignment portion **46** and also adjacent the

optical fiber bores **24, 26**. The ribbon alignment portion **48** is generally rectangular in cross section as best seen in FIGS. 5-7 and assists in orienting the optical fibers, which are illustrated in FIG. 5 to be an optical fiber ribbon **30**. The ribbon alignment portion **48** could also have other shapes in cross section, including for example, oval, rectangular with rounded corners, etc., as long as the ribbon alignment portion **48** assists in orienting the optical fibers for insertion into the optical fiber bores **24, 26**. As with the buffered optical fibers **34**, the optical fiber ribbon **30** is guided into the alignment portion **40** by the lead-in portion **38**. The optical fiber ribbon **30** passes through the buffered alignment portion **46**, and may be oriented in a horizontal direction by the rib **54**, if present. As the optical fiber ribbon **30** approaches the shoulder **56**, the optical fibers **36** of the optical fiber ribbon **30** are funneled into and aligned by the ribbon alignment portion **48** to enter the optical fiber bores **24, 26**. As can be seen in FIGS. 4, 6, and 7, there may also be a lead-portion **58** at the entrance to the optical fiber bores **24, 26** to further assist in aligning the optical fibers **36** with optical fiber bores **24, 26**. Thus, the multi-fiber ferrule **10** aligns both buffered fibers as well as optical fiber ribbons. Connectorized buffered fibers and an optical ribbon that use the multi-fiber ferrule **10** are illustrated in FIGS. 9 and 10.

[026] The multi-fiber ferrule **10** of the present invention is a windowless ferrule. The window in the prior art ferrules in FIGS. 10 and 11, is used to permit pre-assembly of the ferrule, to assist in aligning the fibers in the optical fiber bores and to inject the epoxy into the ferrule to hold the optical fibers in the ferrule. However, the presence of the window and using it as an injection point of epoxy for the ferrule tends to be rather messy. The epoxy can easily flow out of the window during injection, handling of the ferrule prior to curing, and even during curing. The multi-fiber ferrule **10** of the present invention does not need to have a window for aligning the optical fibers or to inject the epoxy. The alignment portion **40** provides a sufficient guide for the optical fibers as discussed above. Thus, with the multi-fiber ferrule **10** of the present invention, the epoxy can be injected into the ferrule before the optical fibers are

inserted into the ferrule. When the epoxy is injected into a prior art windowless ferrule, the optical fibers typically are not centered in the ferrule. In fact, the optical fibers tend to be pushed to one side, preventing the epoxy from adequately securing the optical fibers in the ferrule. However, that problem does not exist with the present invention as the alignment portion **40** appropriately centers and maintains the optical fibers in the ferrule, thereby allowing the epoxy to completely surround the optical fibers and provide a good bond.

[027] It will be apparent to those skilled in the art that various modifications and variations can be made in the multi-fiber ferrule of the present invention without departing from the spirit or scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims and their equivalents.